Testprotocol Smart meter connectivity

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Version log	Version log	Date	Writer	Remarks
	0.1	2020-4-22	DJS	Concept
	0.2	2020-06-04	DJS	Concept
	0.3	2020-06-18	DJS	Added NB-IoT
	0.9	2020-07-23	DJS	Added review comments.
	1.0	2021-05-21	Umlaut	Update and rewrite from testing perspective
	1.1	2021-07-06	DJS / GS	Added feedback, Nb-IoT removed
	1.2	2021-10-02	DJS	Added final remarks

Contents

1 Preface

Goal of this document is to create a standard test plan which can be used by a supplier for testing. The protocol can be used in different test labs which are suitable for doing RF tests for telecommunication.

1.1 Reason behind this test protocol

Charging Stations in the Netherlands are equipped with smart meters supplied by the Dutch grid operators. It is essential for the Dutch grid operators to get remote contact with the smart meter. It is expected that in the future the charging station needs to be controlled because of net management.

The Dutch grid operators defined a standard which is used to validate if the charging station is suitable for usage in the Netherlands.

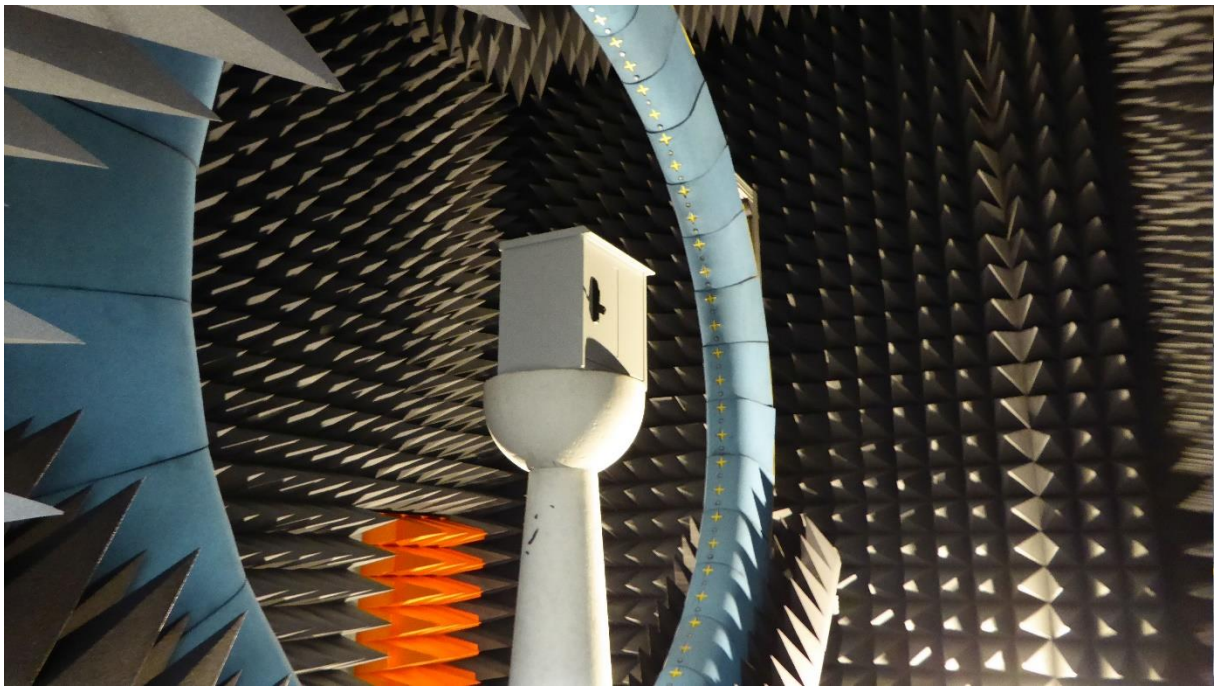
This test protocol is focused on the radio accessibility of smart meters when used inside a charging station.

1.2 Assumptions

1. Smart meters are always used as-is: without external or separate radio antennas.
2. Charging stations always use poly phase (PP) smart meters.
3. Testing of radio accessibility is done in an independent and professional RF test lab. Please consult ElaadNL before conducting the tests, to assess whether ElaadNL will accept a report from the selected RF lab.
4. Testing is done on a charging system which is equal to the final product as placed into the field.
5. Charging station is powered on, but not charging.
6. If multiple versions of the charging system are using the same cabinet, testing is required on all configurations.

2 Test setup

To test the radio accessibility of a smart meter in a charging station, tests can be done in a radio laboratory for testing telecommunication equipment. Radio laboratory shall be equipped with anechoic chamber (see below image). Radio laboratory shall house a charging station and shall have three phase power supply in the chamber. It is important to know that weight and size of the charging station affect the size of the required anechoic chamber.



2.1 Test principle

Main goal for testing is to ensure that signal attenuation introduced by the charging station (when meter is mounted inside it) is not causing signal loss higher than 8dB. This means that if average measured signal level (see chapter 2.2) with standalone meter is e.g. -80.0 dBm then minimum acceptable measured signal level when meter is inside charging pole shall be at least -88.0 dBm.

Standard signal reception sensitivity testing is done by performing TIS and TRP measurements according to the CTIA Test Plan for Wireless Device Over-the-Air Performance V3.8.2 (April 2019, link: https://api.ctia.org/wp-content/uploads/2019/04/CTIA_OTA_Test_Plan_3_8_2.pdf). However, for the specific reasons behind this testing protocol, where only attenuation of charging station needs to be evaluated, TIS and TRP measurements would unnecessarily introduce additional efforts and costs.

Instead of performing TIS and TRP measurements, test network simulator (e.g. R&S CMW500 or Anritsu MD8475A/MD8475B) shall perform signal measurements by receiving the feedback from smart meter communication modem (more details in chapter 2.2).

This test is repeated for meters with different communication technologies.
For this test a set of test meters is used. This set represents the different smart meters communication principles (CDMA, LTE, etc.) which are used in the Netherlands.

To minimize influence of environmental variation it is mandatory that all tests with one type of smart meter are done in the same lab and within a short timeframe (1-2 days).

It is the responsibility of the Dutch grid operators/NBNL to keep this set of smart meters equal to the actual set of smart meters which are used for charging stations. Smart Meters can be requested by contacting ElaadNL (website: https://www.elaad.nl/, email: info@elaad.nl).

2.2 How signal attenuation is measured

Signal level measurements shall be performed with standalone meter (outside measurements) and with meter mounted inside the charging station (inside measurements).

Measurements outside the charging pole shall be performed in good radio conditions and shall target following radio signal levels per technology:

- LTE Cat1, LTE Cat-M1: RSRP ~ -80dBm
- CDMA: RSCP ~ -60dBm

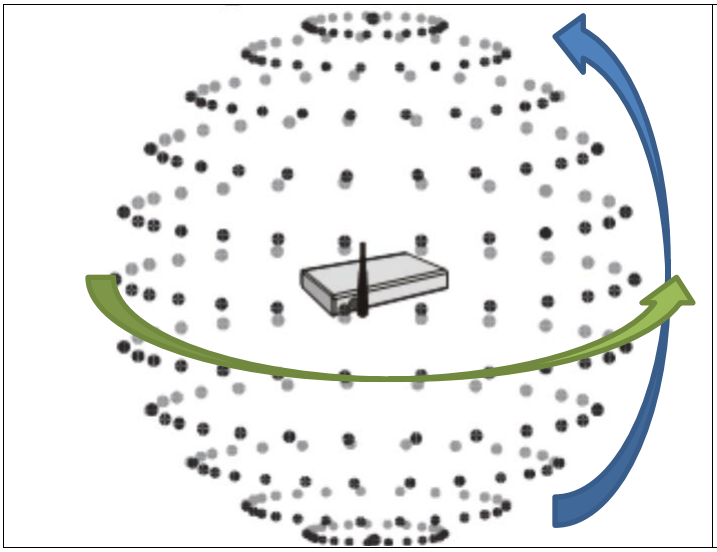
Because the construction of the charging system is fixed, the position of the smart meter in the charging system also determines the position of the smart meter for the measurement without charging station. Outside measurements must be done on the exact same height as during the execution of inside measurements. For inside measurements charging station shall not be modified by any means and should be exactly the same as the one that is planned to be deployed in the field.

Measurements shall be performed in 3 dimensions and at the points defined in chapter 2.2.1. For each individual point there shall be at least 100 measurement samples collected to ensure reliable average value.

Measurements shall be performed with the test network simulator which has the option of collecting direct feedback from smart meter module (e.g. via periodic measurement reports).

2.2.1 Measurement points

To reduce test time measurement, due to 3 dimensions, it is possible to use a reduced set of measurement points. Below an example using the Distributed Axis System.



Measure signal level vertical (blue) on 5 points (30,60, 90, 120 and 150 degrees) and horizontal (green) on 12 points (0,30,60…330 degrees). Total points: 5*12=120 points.
Measure both Theta-Polarization and Phi-polarization. Using these measurements, average signal level can be calculated.

See table below for the required minimum number of measurement points.

	Theta (elevation)	Phi (azimuth)	Total points
Signal level	5 x 12 points	5 x 12 points	120

2.3 Test report requirements

The test report requires the following information:

Used equipment:

- Information about the Charging System under test.
- Information regarding used anechoic chamber
- Information about used test equipment (type serial number, calibration date etc.)
- Information about the used Smart Meters (meter number)

Measurements:

- Measurement results of meter mounted into Charging Station
- Measurement results of meter without Charging Station
- Calculations to show that the measured signal loss is within required limits.
- Detailed information regarding which values which must be measured for each communication principle are available in section 3.

3 Overview of required tests

In this section you will find specific information regarding different communication types which are used for Smart Metering within the Netherlands and the tests related to it.

3.1 LTE Cat1 Smart Meter

3.1.1 Test environment: (band, channel etc.)

For LTE Cat1 the following environment needs to be tested:
Protocol: LTE Cat1
Band: 20 (800MHz), 3 (1800MHz), 8 (900Mhz).
Channels to be tested: Upper, middle and lower channel of each band.

For band 20 channels to be measured are:

	Low	LTE channel	Middle	LTE channel	High	LTE channel	Bandwidth (MHz)
Uplink	832 MHz	24150	847 MHz	24300	862 MHz	24449	5
Downlink	791 MHz	6150	806 MHz	6300	821 MHz	6449	5

For band 3 channels to be measured are:

	Low	LTE channel	Middle	LTE channel	High	LTE Channel	Bandwidth (MHz)
Uplink	1710 MHz	19200	1747.5 MHz	19575	1785 MHz	19949	5
Downlink	1805 MHz	1200	1842.5 MHz	1575	1880 MHz	1949	5

For band 8 channels to be measured are:

	Low	LTE channel	Middle	LTE channel	High	LTE channel	Bandwidth (MHz)
Uplink	880 MHz	21450	897.5 MHz	21625	915 MHz	21799	5
Downlink	925 MHz	3450	942.5 MHz	3625	960 MHz	3799	5

3.1.2 Smart meter used for testing

Contact ElaadNL for a LTE Cat1 PP smart meter which will be supplied by one of the grid operators. The smart meter needs to be specifically configured for usage into a test environment.

3.1.3 Signal loss

Requirement: signal loss must be less than 8 dB on each tested band/channel combination.

3.1.4 Measurement values required for test reports

For each band and channel combination the following table needs to be part of the test report:

	Signal level
Meter only	RSRP_meter (dBm)
Meter in Charging station	RSRP_chrg (dBm)
Difference (less then 8 dB)	RSRP_meter – RSRP_chrg <= 8dB

3.2 LTE Cat-M1 Smart Meter

3.2.1 Test environment: (band, channel etc.)

For LTE Cat-M1 the following environment needs to be tested:
Protocol: LTE Cat-M1
Band: 20 (800MHz), 3 (1800MHz), 8 (900Mhz).
Channels to be tested: Upper, middle and lower channel of each band.

Network downlink parameters to be used:

- Sub-Carrier SC = 12
- Sub-Carrier-Spacing = 15 kHz
- Number of Resource Blocks RB = 6
- Transmission Bandwidth = 1.08 MHz

For band 20 channels to be measured are:

	Low	LTE channel	Middle	LTE channel	High	LTE channel	Bandwidth (MHz)
Uplink	832 MHz	24150	847 MHz	24300	862 MHz	24449	5
Downlink	791 MHz	6150	806 MHz	6300	821 MHz	6449	5

For band 3 channels to be measured are:

	Low	LTE channel	Middle	LTE channel	High	LTE Channel	Bandwidth (MHz)
Uplink	1710 MHz	19200	1747.5 MHz	19575	1785 MHz	19949	5
Downlink	1805 MHz	1200	1842.5 MHz	1575	1880 MHz	1949	5

For band 8 channels to be measured are:

	Low	LTE channel	Middle	LTE channel	High	LTE channel	Bandwidth (MHz)
Uplink	880 MHz	21450	897.5 MHz	21625	915 MHz	21799	5
Downlink	925 MHz	3450	942.5 MHz	3625	960 MHz	3799	5

3.2.2 Smart meter used for testing

Contact ElaadNL for a LTE Cat-M1 PP smart meter which will be supplied by one of the grid operators.
The smart meter needs to be specifically configured for usage into a test environment.

3.2.3 Signal loss

Requirement: signal loss must be less than 8 dB on each tested band/channel combination.

3.2.4 Measurement values required for test reports

For each band and channel combination the following table needs to be part of the test report:

	Signal level
Meter only	RSRP_meter (dBm)
Meter in Charging station	RSRP_chrg (dBm)
Difference (less then 8 dB)	RSRP_meter – RSRP_chrg <= 8dB

3.3 CDMA-450 Smart meter

3.3.1 Test environment: (band, channel etc.)

For CDM450 the following environment needs to be tested:
Protocol: CDMA
Band: 450MHz
Channel: 107 is mandatory. Channel 157 is optional.

For CDMA the channels to be measured are:

	Ch 107	Ch 157
Uplink	452.65 MHz	453.9 MHz
Downlink	463.65 MHz	463.9 MHz

3.3.2 Smart meter used for testing

Contact ElaadNL for a CDMA450 PP smart meter which is supplied by one of the Grid operators.
The smart meter needs to be specifically configured for usage into a test environment.

3.3.3 Signal loss

Requirement: signal loss must be less than 8 dB on each tested band/channel combination.

3.3.4 Measurement values required for test reports

For each channel (107 and option 157) the following table needs to be part of the test report:

	TRP
Meter only	RSCP_meter (dBm)
Meter in Charging station	RSCP_chrg (dBm)
Difference (less then 8 dB)	RSCP_meter – RSCP_chrg <= 8dB

4 Wireless communication of Smart Meters changes over time.

From time to time new types of wireless communication is used for smart metering and older types of communication are abandoned.

Because of this the test protocol is changed to reflect the actual state of used smart meters for charging points.

Contact ElaadNL for the last update regarding the actual use and availability of smart meters in use of charging stations.